AutoChargerX

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Product Pitch

There are two main approaches for people to charge their electronic devices: wired charging and wireless charging. However, wired charging forces people to stay close with their devices and wireless charging requires perfect alignment for charging thus having a high failure rate.

To address the problems mentioned above, our project, **AutoChargerX**, introduces a new way in wireless charging technology, addressing the frustrations of wired and misaligned wireless chargers. By utilizing **a 3-axis stepper motor gantry system, an underdesk device detection and control feedback computer vision system, monitoring softwares, and a sandwich glass table top with 4 wireless charging pads**, our **smart charging table automatically detects and aligns** with electronic devices such as your cell phone, allowing seamless wireless charging for multiple devices **without manual intervention**.

Overall, the system has a **~93.3%** electronic device detection accuracy within **1 second**. The charging pad - electronic devices automatch time is **~5.47 seconds** on average and the charging starts **~0.8s** on average after successful alignment.

System Architecture

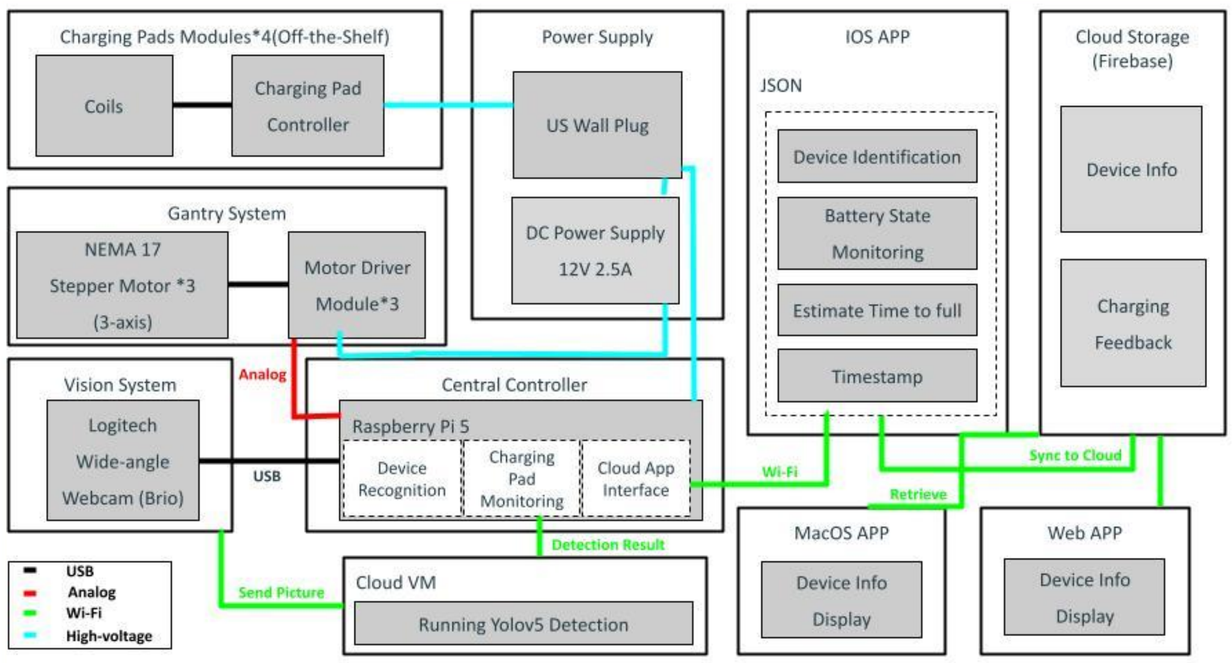

Figure 1. Block Diagram for system architecture

The system leverages a **Raspberry Pi 5** as its central controller, utilizing GPIO pins to generate **PWM signals** for precise motor driver and motor control. A wide-angle camera captures **continuous image frames**, which are transmitted to a **cloud VM** for real-time phone detection using **YOLOv5** machine learning model, and then detected coordinates are send back to Raspberry Pi. The platform also features a comprehensive device management system, which allows users to monitor multiple devices simultaneously. Upon installing the **mobile application**, user **data synchronizes with cloud storage**, enabling device tracking through either a **macOS application** or **web interface**.

System Description

Gantry Subsystem

It use timing belt and 3 motors to achieve the manipulator precise movement in 3-axis. The manipulator has four magnetics tips which will be used to attached to the glass desktop and move the charging pads inside.

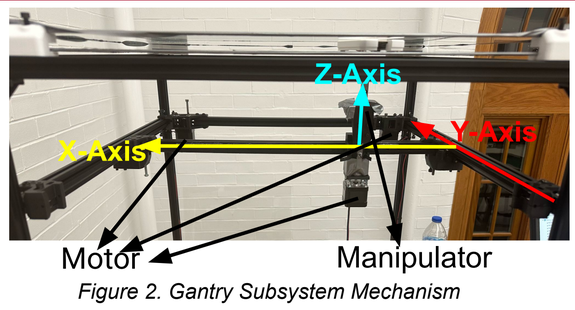

Figure 2. Gantry Subsystem Mechanism

Charging Pads

The wireless charging modules has a LED light on the PCB for charging status indication. The 3D-printed case with magnetics tips for attaching to gantry manipulator.

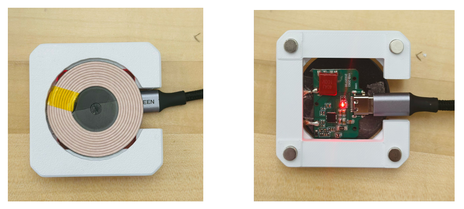

Figure 3. Charging Module with Custom Case & Magnets

Vision Subsystem

It features a wide-angle camera under table. By utilizing YOLOv5 model that is running on cloud, it could detect devices on tabletop and send location command to gantry system for charging pad movement. It also monitor lights under the charging pads which serves as a indicator for success alignment.

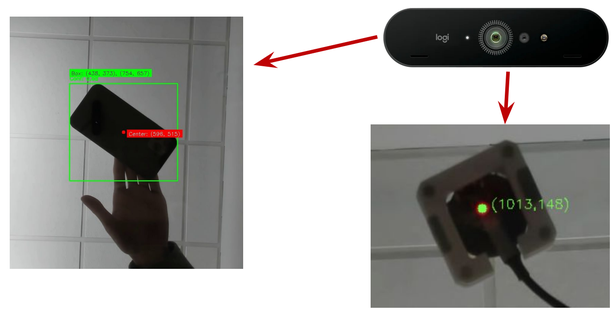

Figure 4. Computer Vision for Device & Charging Light Detection

Figure 5: Phone App,Web App, and MacOS App (from left to right)

Software System

The software ecosystem consists of three interconnected applications: an iOS app, macOS app, and web interface. When installed, the iOS app generates a unique device identifier and streams real-time data to Firebase, including battery level, charging status, thermal state, and timestamps. Both the macOS and web applications pull this data from Firebase, enabling users to monitor comprehensive charging metrics across all their registered devices.

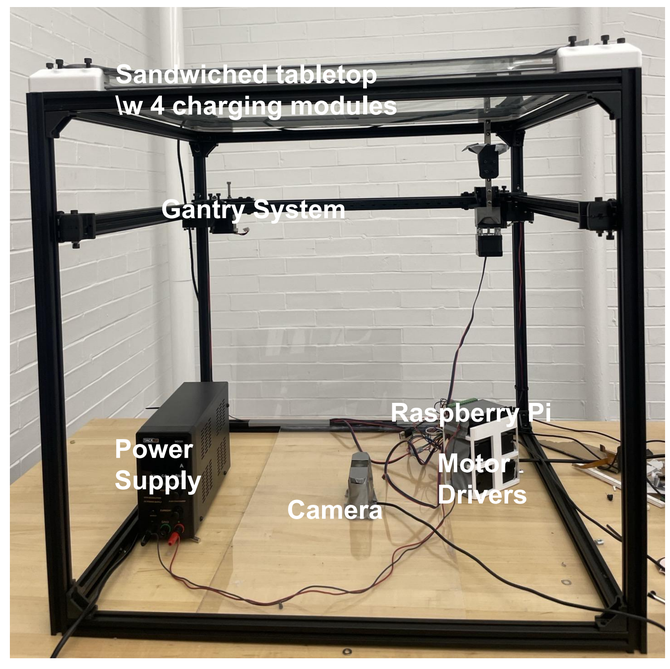

Figure 6: Overview of System Design

Conclusions & Additional Information

System Assessment

The system delivers automated device charging through intelligent detection and integrated software solutions. It identifies compatible devices, manages charging pads, and enables real-time monitoring through iOS, macOS, and web applications, allowing users to track multiple devices charging simultaneously via their preferred interface.

Takeaways

- Alternative approaches using existing components
- Rapid prototyping/component selection techniques
- Troubleshooting and debugging from SW, HW, Meche aspects

Future Development

- PCB and commercial level integration of the system
- Appearance design and various table size

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System Evaluation

Use-Case Requirements

Charging Initiation: Automatically align charging pad with user's device
Fast detection/ Accurate alignment/ Quick Response

During & After Charging: Device monitoring with software and device APIs
Status Tracking/ Overheating Prevention
Finish charging fast/ Automatically stop

Design Requirements (30 Tests)

Metric	Target	Actual
Auto Device Detection	<=1sec, <=1cm	Success Rate 93.33%
Auto Match and Alignment	<= 10sec, <= 1cm	Avg Charging start time: 1.4s
Charging Start	= 2sec after alignment	Avg Alignment Error: 4.76mm Avg Alignment Time: 5.47sec
Fully Charge Time	<=45min	Completed
Phone Live Battery Display	<= 500ms Update rate	Completed
Temperature Control Monitor	Threshold at 50℃	Completed